

## SECOND ANNUAL MONITORING REPORT FOR OPERABLE UNIT 1 MITIGATION WETLAND AT ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

### Background

This is the second annual monitoring report for the mitigation wetland established in 1993 in Operable Unit (OU) 1 at the Rocky Flats Environmental Technology Site (RFETS), Colorado. This wetland was established as mitigation for a wetland area that was impacted by the OU1 French Drain Project. Monitoring of this mitigation wetland was requested by the Environmental Protection Agency (EPA) at a meeting held at RFETS on April 1, 1993. At this meeting, it was agreed that 2,000 square feet of wetland should be established with cattails planted on approximately one-foot centers, and that an 85% survival rate (0.85 cattails per square foot) would be the minimum acceptable. It was also agreed that a monitoring report would be submitted to EPA and the Colorado Department of Health (CDH)(now called the Colorado Department of Public Health and Environment) each year by the end of August, for a period of five years. The first annual monitoring report was transmitted to EPA and CDH in August 1993.

The OU1 mitigation wetland area at RFETS was planted with a total of approximately 2200 common cattail (*Typha latifolia*), 100 great bulrush (*Scirpus validus*), 100 chair-maker's rush (*Scirpus americanus*), and 100 coyote willow (*Salix exigua*). The planting was done on May 6, 7, 10, and 11, 1993. The planting stock was obtained through a local nursery. The nursery obtained cattails from a grower in Montana because locally grown stock was not available within the time that EPA wanted the planting to be completed.

The cattail and willow planting materials consisted of 10 cubic inch containerized stock (containerized tubelings approximately 8" long). The cattail planting stock consisted of plants that had grown for one season in plastic conical containers. The stems had been cut back to approximately 1 inch, and the plants were just breaking dormancy. The great bulrush and chair-maker's rush planting material consisted of 2 inch square pots. The cattails were planted in holes made with sharpened broom handles. A tile spade was used to dig holes in which to plant the great bulrush, chair-maker's rush, and willow. The cattail was the only vegetation that EPA required in the mitigation wetland area. The willow, great bulrush, and chair-maker's rush were planted to add some diversity to the vegetation in the wetland.

At the time of planting, the water depth in the lowest (deepest) areas of the mitigation wetland was approximately one foot. Cattails were planted throughout the entire wetland mitigation area, even though some of the areas were submerged. The great bulrush and chair-maker's rush were planted in isolated pockets among the cattails near the outside edges of the mitigation wetland. The willows were planted just outside the perimeter of the area planted with cattails. The area planted with willows was not included in the total area identified as being successfully revegetated with cattails. The planted material was in very good condition at the time of planting. Approximately 1-2% of the cattail tubelings did not have adequate root systems developed to hold the planting medium together and appeared to be dead. These were not planted.

ADMIN RECCRD

A-OU01-001399

11/88

The mitigation wetland was first evaluated on August 17, 1993 to determine the density of cattails and the surface area covered by the cattails. At that time the cattail density was 3.1/ft<sup>2</sup>, and the area covered by the planted cattails was approximately 1860 ft<sup>2</sup>. This information was reported in the first annual mitigation report.

### **Monitoring Materials and Methods**

A quadrat sampling method was used to determine the density of the cattails in the mitigation wetland. One half square meter quadrats (one meter x one half meter rectangles) were used to sample the vegetation on August 4, 1994. This quadrat size was considered to be large enough to reduce boundary error to acceptable levels, yet small enough that the number of plants within each quadrat was small enough to obtain accurate counts. Density was determined by counting the number of cattails showing current year growth in each quadrat. The quadrat counts were multiplied by 2 to obtain the density per square meter. This number was converted into a density per square foot to allow comparison with the EPA criteria of planting on one foot centers, which would result in an overall density of one cattail per square foot.

The quadrat sampling procedure used to determine the density of cattails in the mitigation wetland is taken from the Comprehensive Onsite Determination Method, as described in both the 1987 Corps of Engineers Wetland Delineation Manual and the 1989 Federal Manual for Identifying and Delineating Jurisdictional Wetlands. This procedure is simply one way of randomly locating quadrats that can be sampled to give an accurate estimate of the overall density within the population of interest. One minor modification to the procedure was necessary. The modification consisted of using five transects instead of the three that were recommended in the manuals. This was necessary in order to get enough sample plots to have a statistically valid sample size, without having to overlap several quadrats along each transect.

The sampling procedure involved laying out a baseline perpendicular to the hydrologic gradient. Sampling transects were then laid out perpendicular to the baseline. The transect locations were determined by dividing the baseline into a number of equal segments, and using a random number generator to determine the transect location within each segment.

Quadrats were located on observation points along the centerline of the transects by placing one corner of the transect on the observation point and placing one edge of the quadrat adjacent to the transect line. Observation points were located along the transects at a random number-generated distance from the edge of the wetland. One half square meter rectangular quadrats were used. Quadrat frames were constructed of half inch PVC pipe.

Initially, six quadrats were counted. One quadrat was located in each of the four shortest transects, and two quadrats were located in the longest transect in order to assure that the entire wetland area was sampled. The values obtained from these quadrats were substituted into the following sample size estimation formula for a univariate, normally distributed vegetation characteristic. This calculation gave the number of samples that were necessary to obtain a 90 per cent confidence level (10% chance of error) that the sample mean obtained from the quadrat counts was within 10% of the actual population mean. By using the following sample

size estimation formula, it was calculated that 5 additional samples (quadrats) were needed, for a total of 11 quadrats. Numbers and calculations for the sample size estimation formula are shown on the field data form included at the end of this report.

$$n = \frac{t^2 s^2}{(kX)^2}$$

n = the number of samples required to obtain the required confidence level and precision.

t = the t-variable for the sample at the stated level of error.

s = the standard deviation of the sample.

k = the proportion or precision that the true difference of the sample mean occurs from the population mean.

X = the sample mean.

The area of the mitigation wetland was determined by surveying in wire flags placed around the perimeter of the wetland vegetation to identify the boundary of the surviving planted cattails. Flags were also used to mark the boundary of the willows planted around the perimeter of the mitigation wetland. Both the area covered by the surviving cattails, and the area covered by the willows were calculated.

## Results

A photograph of the mitigation wetland, taken August 16, 1994 is shown in Figure 1. The mean density of cattails in the mitigation wetland calculated from the 11 sample quadrats counted on August 4, 1994 was 21.3/m<sup>2</sup> (2.0/ft<sup>2</sup>). The sample standard deviation for the quadrat counts was 2.01. The 11 quadrat sample size gave a 90% statistical confidence that the sample mean was within 10% of the population mean.<sup>1</sup>

The size of the area where planted cattails were surviving on August 4, 1994 was determined to be approximately 1670 ft<sup>2</sup>. This area does not include the wetland vegetation (primarily cattails, cottonwood saplings and willows in the northwest part of the wetland area) that was already present in the general area before the cattails were planted. The total area of the mitigation wetland covered by the planted willows is approximately 180 ft<sup>2</sup>. Both the cattails and willows combined cover an area of approximately 1850 ft<sup>2</sup>.

The willows, great bulrush, and chair-maker's rush plantings were not quantitatively evaluated, but they are surviving, and appeared to be approximately the same density as when

<sup>1</sup> The previous 1993 monitoring report used a statistical analysis that indicated a 90% statistical confidence that the sample mean was within 5% of the sample mean (k = 0.05 in the equation used on the field data sheet). Since 10% is the more commonly used number, the value of k was changed to 0.10 for this report (indicating that the sample mean is within 10% of the population mean) and the 10% statistic will be used for subsequent reports in order to make this figure more comparable with other similar data reported in the literature.

they were planted. Some great bulrush and coyote willow had also established in areas where they had not been planted.

## Discussion

The density of the cattails in 1994 (2.0/ft<sup>2</sup>) is somewhat less than the density was in 1993 (3.1/ft<sup>2</sup>). This density is still above the minimum density of 0.85 cattails/ft<sup>2</sup> required by the EPA.

The area of the surviving cattails (1670 ft<sup>2</sup>) is somewhat smaller than it was last year (1860 ft<sup>2</sup>). The difference in area is due primarily to the loss of some of the cattails along the edges of the wetland since last year, which caused portions of the edge of the wetland to be flagged at a lower elevation this year. Field measurements also include some error, which may be plus or minus. If the area where the willow plantings have survived is included in the area considered to be mitigation wetland, the total area is approximately 1850 ft<sup>2</sup>.

Based on general observation, the distribution of the planted cattails is generally the same as it was in 1993. The cattail density still appears somewhat lower in areas that remained submerged for a period of weeks after planting. Survival was expected to be lower in these areas, since the young cattail plants are not able to withstand extended inundation unless the stems are long enough to protrude above the water. It appears that some of the cattails that were surviving in the higher elevations last year have been lost. The lack of rain throughout the late spring and summer probably contributed to the apparently low survival rate in the drier areas.

Natural establishment of cattails appears to be occurring mostly in the extreme west end of the wetland (Figure 2) and at the point where the drainage ditch coming down the hillside enters the wetland. Cattails in these two areas are much denser and taller than in other areas that were planted. None of the sample quadrats were located in these two areas. It is still possible that additional cattails will establish in the wetland, either as erect shoots developing from rhizomes, or as individual plants established from seeds from nearby seed sources.

The variations in bottom contours and in water levels present in the mitigation wetland were expected to result in some areas not becoming vegetated the first year. This situation is similar to what would be expected in vegetation reestablishment in natural wetlands after a major disturbance. Not all vegetation reestablishes the first year. Areas that are too dry or too wet will have little or no wetland vegetation develop in any given year. In subsequent years, as water levels fluctuate, areas that were initially too wet or too dry will eventually experience water levels that are suitable for vegetation development.

Wetland vegetation that was already present adjacent to the mitigation wetland area included primarily cottonwood (*Populus sp.*), willow (*Salix sp.*), and cattail (*Typha sp.*) growing in the northwest corner of the wetland. This vegetation does not appear to have been significantly impacted by the mitigation wetland construction. A few cottonwood seedlings have established in the mitigation wetland area adjacent to the larger cottonwoods trees, and the cattails in the extreme northwest corner are spreading onto the mitigation wetland.

Other species of vegetation have become established in the wetland. Table 1 gives a list of species that were observed on August 4, 1994 in the mitigation wetland area, below the apparent high water mark. Most of these species are represented by scattered individuals. The only vegetation that has become established in any significant numbers is the *Eleocharis* that is colonizing some of the wetter parts of the mitigation wetland. The facultative upland (FACU) and facultative (FAC) species are generally found around the upland edges of the wetland. There are scattered individuals of various species found throughout the mitigation wetland, but no species have established to the point that they appear to be competing with the planted cattails.

The mitigation wetland has been entirely dependent upon runoff from precipitation during calendar year 1994, with no water artificially applied. The preceding three month period has been unusually warm and dry. Total precipitation at RFETS for May, June, and July was 2.89 inches, which is only 47.5% of the normal precipitation (6.09 inches) for that time period. Average high temperatures for May, June, and July were 7.4°, 10.7°, and 5.3° above average, respectively.

The primarily bentonite bottom forms a hard crust as it dries out, which likely reduces the establishment of vegetation. Many of the plants that have established on their own appear to have established in cracks in the bentonite, where moisture is retained longer, the surface does not harden as quickly, and seeds find an environment more suitable for establishment.

Some soil material is still eroding into the wetland from a small gully in the hillside to the north of the wetland. This material appears to have covered a few of the cattails that were planted on the north side of the wetland.

Raccoon droppings, deer tracks, and a recent deer bed were found in the mitigation wetland area.

The cattails in the mitigation wetland are not growing as well as if there had been abundant precipitation throughout the year. Application of water is possible, and would enhance the growth of the existing planted vegetation, as well as encourage additional growth from seeds that are blown or otherwise transported into the wetland. Application of water would make it more difficult to determine, within the five year monitoring period, whether the wetland is likely to survive without periodic human intervention.

TABLE 1

PLANT SPECIES OCCURRING IN OU1 MITIGATION WETLAND, 1994

Scientific Name <sup>1</sup>	Common Name <sup>1</sup>	Indicator Category <sup>2</sup>
<i>Agropyron smithii</i>	Western Wheatgrass	FACU
<i>Agrostis hyemalis</i>	Winter Bentgrass	FACU
<i>Ambrosia psilostachya</i>	Naked-spike Ragweed	FAC
<i>Asclepias incarnata</i>	Swamp Milkweed	OBL
<i>Bromus inermis</i>	Smooth Brome	NL
<i>Bromus japonicus</i>	Japanese Brome	FACU
<i>Bromus tectorum</i>	Cheatgrass	NL
<i>Carduus nutans</i>	Musk Thistle	NL
<i>Carex sp.</i>	Sedge	FACW-OBL
<i>Centaurea diffusa</i>	Knapweed	NL
<i>Cirsium arvense</i>	Creeping Thistle	FACU
<i>Convolvulus arvensis</i>	Field Bindweed	NL
<i>Conyza canadensis</i>	Canada Horseweed	FACU
<i>Echinochloa crusgalli</i>	Barnyard Grass	FACW
<i>Eleocharis acicularis</i>	Least Spikerush	OBL
<i>Eleocharis macrostachya</i>	Creeping Spikerush	OBL
<i>Epilobium ciliatum</i>	Hairy Willow-herb	OBL
<i>Euphorbia serpyllifolia</i>	Thyme-leaved Spurge	NL
<i>Grindelia squarrosa</i>	Curly-cup Gumweed	FACU
<i>Helianthus annuus</i>	Common Sunflower	FACU
<i>Hordeum jubatum</i>	Fox-tail Barley	FACW
<i>Juncus balticus</i>	Baltic Rush	OBL
<i>Juncus torreyi</i>	Torrey's Rush	FACW
<i>Lactuca serriola</i>	Prickly Lettuce	FAC
<i>Melilotus officinalis</i>	Yellow Sweetclover	FACU
<i>Panicum capillare</i>	Witchgrass	FAC
<i>Phleum pratense</i>	Timothy	FACU
<i>Plantago lanceolata</i>	English Plantain	FAC
<i>Plantago major</i>	Common Plantain	FAC
<i>Poa compressa</i>	Canada Bluegrass	FACU
<i>Polygonum aviculare</i>	Prostrate Knotweed	FACW
<i>Polygonum erectum</i>	Erect Knotweed	OBL
<i>Polygonum lapathifolium</i>	Willow-weed	OBL
<i>Polypogon monspeliensis</i>	Annual Rabbit-foot Grass	OBL
<i>Populus deltoides</i>	Plains Cottonwood	NL
<i>Rosa sp.</i>	Rose	UPL-FACU
<i>Rumex crispus</i>	Curly Dock	FACW
<i>Salix amygdaloides</i>	Peach-leaf Willow	FACW
<i>Salix exigua</i>	Sandbar Willow	OBL
<i>Scirpus americanus</i>	Olney's Bulrush	OBL
<i>Scirpus validus</i>	Soft-stem Bulrush	OBL
<i>Sonchus arvensis</i>	Field Sowthistle	FAC

TABLE 1 (Continued)

Scientific Name <sup>1</sup>	Common Name <sup>1</sup>	Indicator Category <sup>2</sup>
<i>Taraxacum officinale</i>	Common Dandelion	FACU
<i>Typha latifolia</i>	Broad-leaf Cattail	OBL
<i>Verbena hastata</i>	Blue Vervain	FACW
<i>Xanthium strumarium</i>	Rough Cockle-bur	FAC

- (1) Nomenclature is taken from the National List of Plant Species that Occur in Wetlands: Colorado (Reed, 1988) for all species that are included on that list. Scientific names for species not found on National List of Plant Species are from the Flora of the Great Plains (Great Plains Flora Association, 1986). Common names for species not found on the National List of Plant Species are not standardized, but are taken from the Rocky Flats Plant Technical Standard EPM-END-CASCL (Current Approved Species Code List).
- (2) Indicator categories are from the National List of Plant Species that Occur in Wetlands: Colorado (Reed, 1988). The Region 5 Indicator (R5IND) was used. Region 5 includes Nebraska, Kansas, and Eastern Colorado.

#### INDICATOR CATEGORIES

**OBL** (Obligate Wetland) - Occur almost always (estimated probability > 99%) under natural conditions in wetlands.

**FACW** (Facultative Wetland) - Usually occur in wetlands (estimated probability 67%-99%), but occasionally found in nonwetlands.

**FAC** (Facultative) - Equally likely to occur in nonwetlands (estimated probability 34%-66%).

**FACU** (Facultative Upland) - Usually occur in nonwetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).

**UPL** (Obligate Upland) - Occur in wetlands in another region, but occur almost always (estimated probability >99%) under natural conditions in nonwetlands in the region specified. If a species does not occur in wetlands in any region, it is not on the National List.

**NL** (Not On List) - Species is not listed on region 5 list. It may be on the National List in other regions.

**NI** (No Indicator) - Insufficient information was available to determine an indicator status.

OU1 Mitigation Wetland - FIELD DATA FORM

Field Investigator(s): JEFF KRAUSE, MARCIA MURDOCK Date: 8-4-94  
Location: OU1 MITIGATION WETLAND Purpose: 1994 MONITORING REPORT  
Sheet 1 of 1

Quadrat	Quadrat Count Plants/0.5m <sup>2</sup>	Plants/m <sup>2</sup>	Quadrat	Quadrat Count Plants/0.5m <sup>2</sup>	Plants/m <sup>2</sup>
1	<u>14</u>	<u>28</u>	9	<u>7</u>	<u>14</u>
2	<u>13</u>	<u>26</u>	10	<u>10</u>	<u>20</u>
3	<u>11</u>	<u>22</u>	11	<u>12</u>	<u>24</u>
4	<u>10</u>	<u>20</u>	12		
5	<u>10</u>	<u>20</u>	13		
6	<u>9</u>	<u>18</u>	14		
7	<u>9</u>	<u>18</u>	15		
8	<u>12</u>	<u>24</u>	16		

Sample size formulas

$$(1) \quad n = \frac{(2ts)^2}{w^2}$$

- = n = the number of samples required
- = t = the t-variable for the sample at the stated level of error
- = s = the standard deviation of the sample
- = w = the width of the desired confidence interval

$$(2) \quad n = \frac{t^2 s^2}{(kX)^2} = \frac{(2.015)^2 (2.7)^2}{(.10 \times 11.17)^2} = \frac{4.06 \times 3.13}{1.25} = \frac{12.71}{1.25} = 10.17$$

- 10.17 = n = the number of samples required
- 2.015 = t = the t-variable for the sample at the stated level of error
- 1.77 = s = the standard deviation of the sample
- 0.10 = k = the proportion or precision that the true difference of the sample mean occurs from the population mean
- 11.17 = X = the sample mean

THE  
QUADRAT  
COUNTS  
NEED TO BE  
ADJUSTED FOR  
STATISTICAL  
CONFIDENCE

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